Technical Memorandum

To:	Mary Beth Marks	From:	Kirk Miller, Jim Maus, Daniel Wiegand
Company:	US Forest Service	Date:	March 14, 2014
Project #:	114-560368A		
Re:	FINAL - Yearly Operations Summary – 2013 Beal Year 6 RO Water Treatment		
CC:	Dale Reckley		

Tetra Tech is pleased to submit this Yearly Operations Summary for the 2013 Reverse Osmosis (RO) water treatment season at the Beal Mountain Mine located 16 miles west southwest of Butte, Montana in Silver Bowl County (**Figure 1, Appendix A**). This yearly report is required as a deliverable for Task 5, Sub Task No. 4 of the Beal Mountain Mine Year 6 Work Order, (contract # GS-10F-0268K; AG-0343-C-13-0001). Data reported includes water volumes treated through the RO Treatment System, heap leach solution level monitoring, heap leach laboratory and field solution chemistry analytical results, and slide dewatering well pumping volumes.

TOTAL LEACH PAD SOLUTION VOLUME TREATED BY RO

The RO System startup began on June 17, 2013. Plowing to access the Beal Mountain water treatment plant building was not needed since most of the snow had melted with the exception of the remnants from the main snow drift on the northeast of the leach pad. After the membranes were installed in the system it was discovered that the first booster pump was not working properly. The pump was removed and taken offsite for repairs. A bolt in the base of the pump has sheared from fatigue and the bolt was replaced along with all the pump seals. The soft start, the mechanism that slowly brings the pump to service speed, also failed and was replaced. The pump was installed back into the system and the soft start was replaced on June 28. The system began treating water just before midnight on Friday, June 28, 2013. At startup the total volume treated meter was 128,120,024 gallons and at the end of the season on September 15, 2013, the meter reading was 142,001,056 gallons. The original contract had called for the RO System to treat 24.5 million gallons of water. The actual treatment volume for the 2013 season was 13,881,032 gallons.

The 2013 season started just one day later than the 2012 season. The system was planned to be started a week earlier but due to the unexpected repair to the first pass booster pump the treatment of water was delayed. Once the system began treating water the total treated volume was tracked by hand due to inconsistencies seen with the totalizer in the computer software. Midway through the treatment season, the issue with the software was resolved and the computer correctly tracked the total gallons treated volume. The Year 6 final treated volume was approximately 11 million gallons less than the previous year due to the lack of water (i.e., sump water level dropping below the sump pump intake). When compared with the final treatment volumes from previous seasons (listed below) the 2013 total volume is considerably lower due to running out of water to treat. In 2013, increasing concentrations of salts and other contaminants in the heap leach pad water caused the gallons treated per day to drop significantly. This resulted in the system efficiency to decrease (i.e., lower percentage of water passed through membranes and higher percentage went to reject).

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- Volume treated during 79 days of 2013 season = 13,881,032 gallons (175,709 gallons per day (gpd))
- Volume treated during 119 days of 2012 season = 24,959,896 gallons (209,747 gpd)
- Volume treated during 147 days of 2011 season = 32,136,432 gallons (218,615 gpd)
- Volume treated during 130 days of 2010 season = 33,638,532 gallons (258,758 gpd)
- Volume treated during 119 days of 2009 season = 25,377,606 gallons (213,257 gpd)

Leach Pad Solution Levels

Leach pad solution levels were measured on May 22, 2013 (before treatment began) and the calculated solution volumes on the leach pad were as follows:

- Sump 1 depth to solution = 67.33 feet, which equates to 21.54 million gallons
- Sump 3A depth to solution = 58.17 feet

Leach pad solution levels were measured on September 25, 2013 (ten days after treatment ended) and the calculated volumes of the leach pad were as follows:

- Sump 1 depth to solution = 79.04 feet, which equates to 6.3 million gallons
- Sump 3A depth to solution = 58.37 feet

Note: the RO treatment system was shut down for the season on September 15th. Therefore, any cone of influence within Sump 1 should have dissipated by the time of measurement on September 25th. Manual measurement on September 16th showed leach pad minimum volume of 3.6 million gallons. All measurements were recorded from the top of the steel plate covering the sump openings. No large snowstorms were experienced during the 2013 treatment season.

Heap leach levels have been recorded manually or by pressure transducers located in Sump 1 and Sump 3A since 2003 (**Figure A**). **Figure B** presents solution elevations and calculated volumes using data from Sump 1.

Figure A

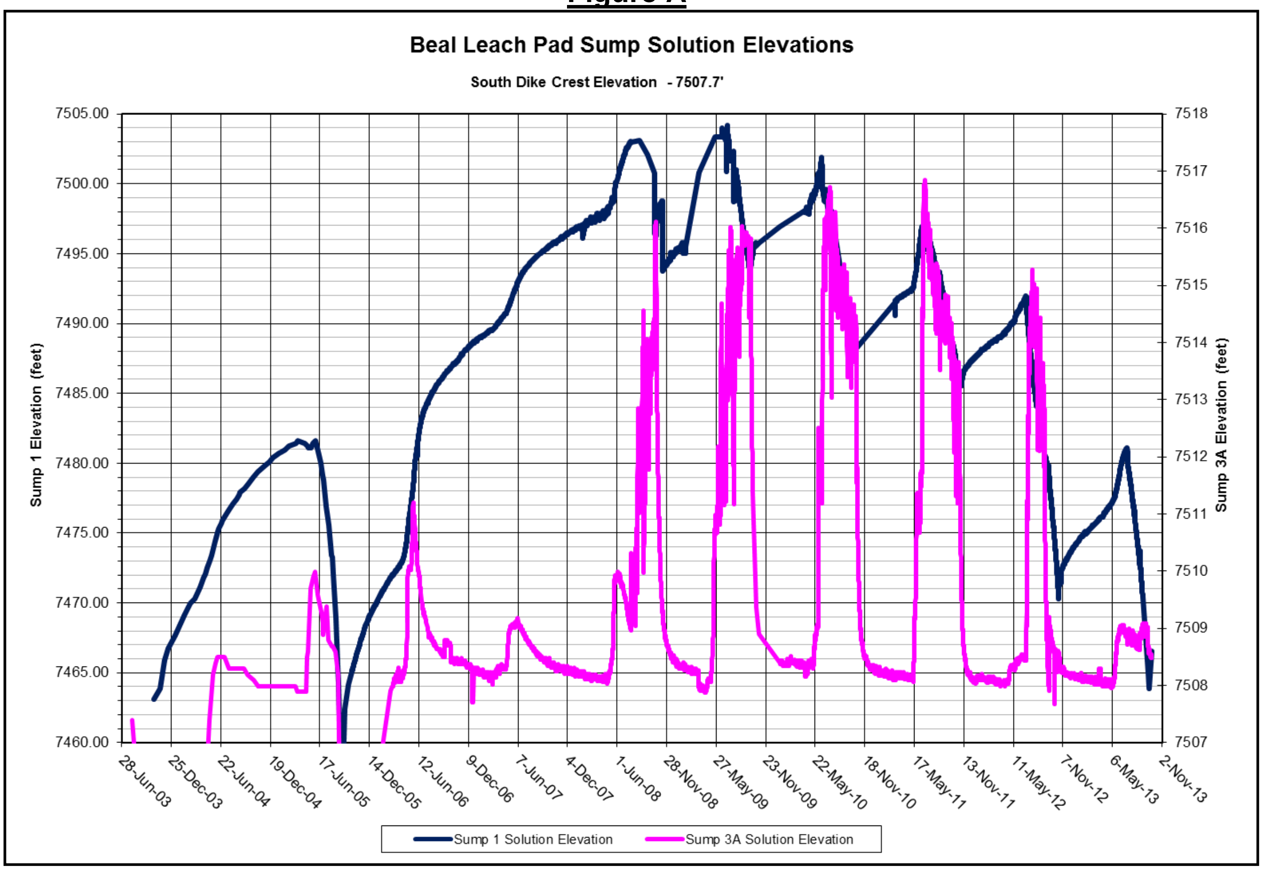
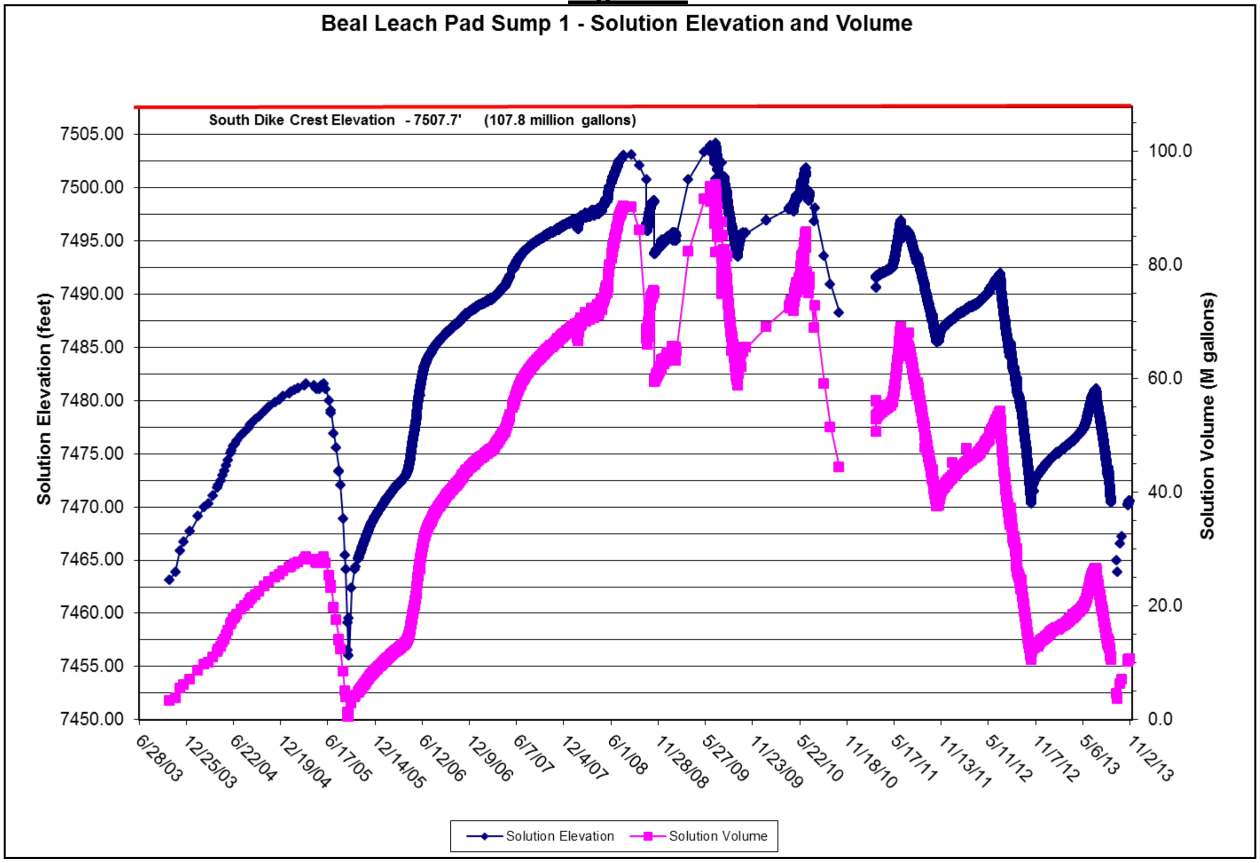


Figure B



Leach Pad Drain Down

Figure B exhibits a pattern of annual solution accumulation equal to approximately 28 to 30 million gallons per year. Most of the annual increases have occurred during the spring runoff period (May through July). However, even during winter's "frozen" conditions the leach pad continues to accumulate solution volume. At this time it is unknown whether the observed frozen conditions increase is due to external groundwater entering the leach pad, equilibration of solution from the elevated north pool to the lower south pool, drain-down of previously saturated material, or a combination of these factors.

Table 1 summarizes the historic data which results in an average of 31.9 gallons per minute (gpm) winter accumulation (or drain-down) rate since 2006, which is slightly lower than last year's cumulative average of 32.1 gpm. Although the leach pad level was drawn below the sump pump intake this treatment season, according to the current leach pad volume rating table, there is still a significant amount of water that is not accounted for in the leach pad. The exact volume of water below the pump intake is unknown primarily due to the inaccuracy of the rating table at lower volumes. Since the water treatment system discharges the reject water back into the leach pad, via the Injection Well, a considerable amount of water is expected to accumulate back into the sump this winter. The exact time it takes for the reject water to return to the sump has not been determined. This accumulation should be seen much earlier than before since the reject discharge has been rerouted to the Injection Well rather than to Sump-3A, which is farther away from Sump-1 and would be expected to take a longer time to flow to the sump.

The leach pad solution accumulation rate decreased from the winter of 2010/2011 to the winters of 2011/2012 and 2012/2013. **Table 1** presents a summary of water accumulation rates on the leach pad during the winter since 2006.

Table 1 – Water Accumulation Rate on Leach Pad - Winter Period			
Date	**Total Volume Change (million gallons)**	**Days Elapsed**	**Gallons Per Minute**
Jan 2006 – March 2006	+3.6	88	28.5
Dec 2006 – March 2007	+5.5	120	31.8
Dec 2007 – March 2008	+4.5	122	25.6
Dec 2008 – Feb 2009	+3.3	67	34.2
Oct 2009 – April 2010	+7.1	167	29.5
Oct 2010 – March 2011	+9.7	162	41.6
Dec 2011 – May 2012	+7.3	152	33.4
Nov 2012 – May 2013	+8.9	203	30.4
Average			31.9

Treatment System Daily Inspection Reports

Copies of the Daily Operation Logs for the 2013 treatment season are attached in **Appendix B**.

TREATEMENT SYSTEM CHEMISTRY RESULTS

Analysis of RO water was conducted using both field and laboratory analysis methods. Results of these programs are summarized below.

Treatment System Field Chemistry Results

Water chemistry was tested in the RO Plant laboratory at least once a week during the 2013 treatment year using field meters and field test kits. Samples were collected from four locations along the treatment flow path. These results were recorded and used to analyze the systems performance as well as to adjust the treatment process. The four monitoring locations are arranged as follows: a). the Raw Water monitoring point is just as the influent water enters the treatment building; b). After Filters is collected after the influent water is filtered through the three greensand filters; c). The treated water (i.e. permeate) is monitored after the 1st Stage and 2nd Stage of the RO. A summary of treatment system field parameters is presented in **Table 2**.

Table 2 - RO Treatment System Summary of Field Parameters				
	Raw Water	**After Filters (Greensands)**	**1st Stage Permeate**	**2nd Stage Permeate**
Temperature (F)	50.4 - 54.1	52.1 - 53.2	52.6 - 54.8	53.0 - 54.6
Turbidity (NTU)	0.38 - 0.66	0.40 - 0.80	--	--
Conductivity (uS/cm2)	8360 - 12940	8400 - 13460	584 - 943	50.7 - 256
pH	8.38 - 9.18	8.4 - 9.36	--	9.21 - 10.49
Cyanide (mg/L)	0.218 - >0.264	--	0.014 - 0.087	0.015 - 0.052
Manganese (mg/L)	0.766 - 1.021	0.976 - 1.321	0.018 - 0.082	0.000 - 0.016
Nitrate (mg/L)	>5.5	--	--	3.1 - >5.5
Nitrite(mg/L)	>0.550	--	--	0.252 - >0.550
Ammonia (mg/L)	>3.34	--	>3.34	1.73 - >3.34
Chlorine (mg/L) (pre-sodium)	--	0.02 - 0.16	--	--
Chlorine (mg/L) (post-sodium)	--	0.00 - 0.15	0.00 - 0.01	--

Treatment System Laboratory Chemistry Results

The 2010 Water Treatment Sampling and Analysis Plan (WTSAP) was reviewed and updated on December 3, 2012 according to current water treatment operations and the changing heap leach chemistry (Tetra Tech, 2012).

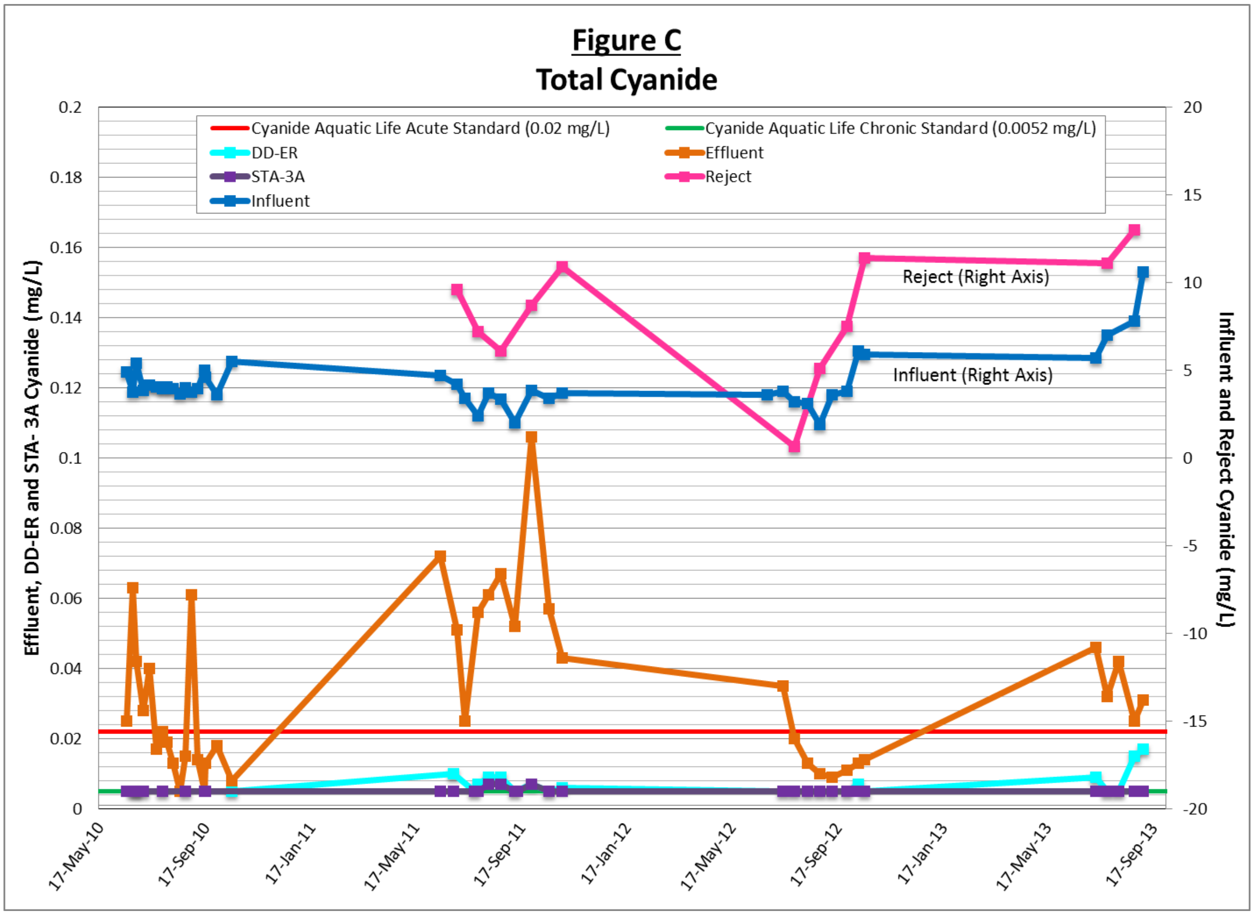
Task 5, Sub-Task No. 2 of the Beal Mountain Mine Year 6 Proposal, contains the sample schedule for monitoring the water treatment plant (Tetra Tech, 2013b). The influent (raw water) and the effluent (2nd stage permeate) were sampled for lab analysis on a bi-weekly basis.

These samples were tested for field parameters (Table 3 of 2012 WTSAP) and also taken to Energy Laboratory in Helena, Montana for laboratory water chemistry analysis (Table 5 of 2012 WTSAP). Monthly sampling of the RO influent, effluent, and reject (2^{nd} stage concentrate) water was also conducted, and analyzed according to Table 6 of the 2012 WTSAP. The 2012 WTSAP also required that in addition to the in-plant sampling, two sample sets associated with the discharge of treated water to a tributary of German Gulch be analyzed according to Table 7 of the 2012 WTSAP. The sample sets were collected from Direct Discharge – End of Rock (DD-ER) and surface water STA-3A stations. DD-ER is located south of the leach pad, northeast of the main pit highwall and just southwest of Pump Station 5. This location is used for the direct discharge from the treatment system and is located at the south end of the riprap channel that was constructed to divert excess water away from the main pit highwall. STA-3A is located farther down German Gulch, southwest of the main Beal access gate and Pump Station 4. The locations of the two direct discharge stations are shown on **Figure 2** (**Appendix A**).

Graphical results of key parameters for influent, effluent and reject, and direct discharge samples are attached as **Figures C** through **G**. The analytical results are summarized below.

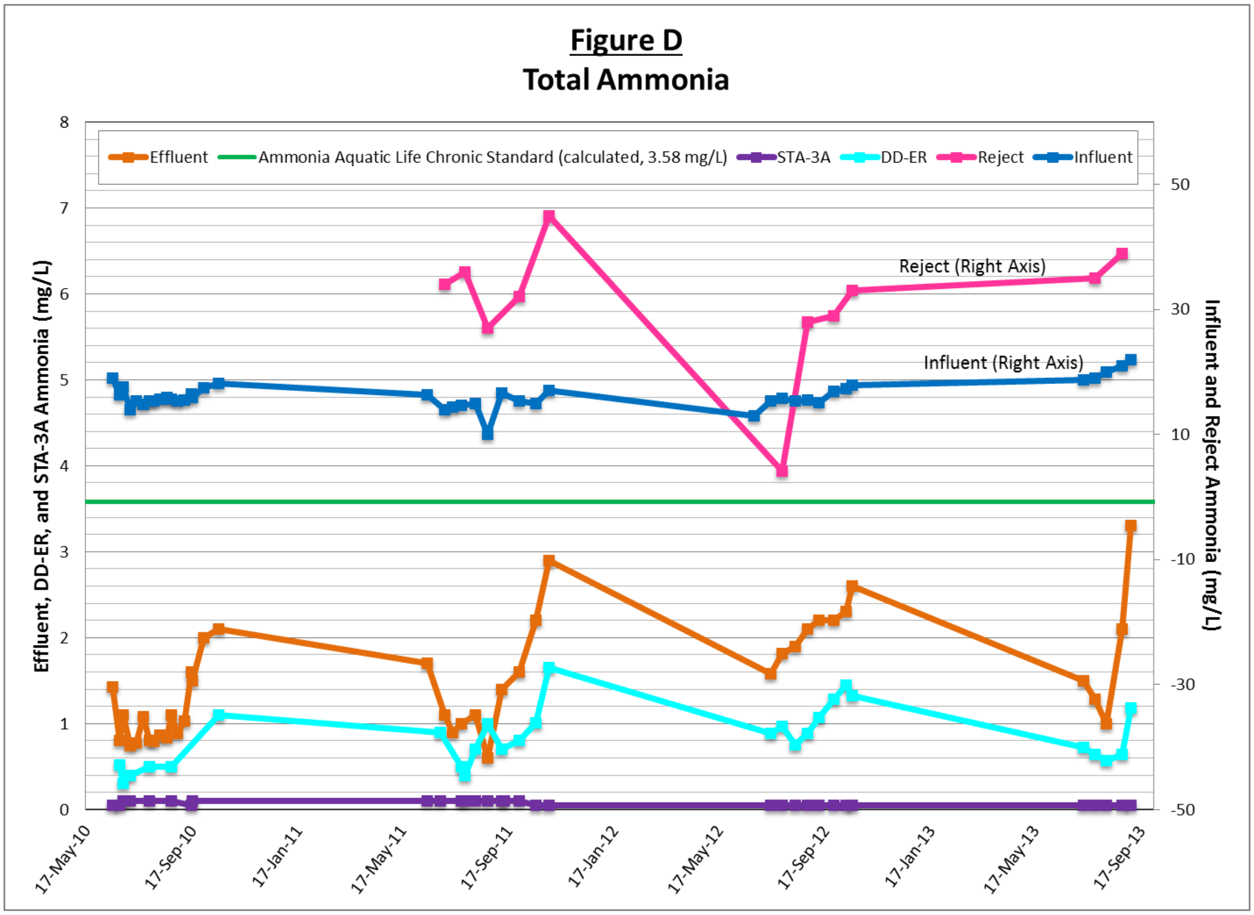
<u>Cyanide (CN)</u>

During the 2013 season, raw water (influent) entered the treatment system at an average of 7.78 milligrams per liter (mg/L) of CN with a maximum of 10.6 mg/L during the September sampling event. The 2^{nd} stage permeate (effluent) water only retained on average 0.035 mg/L of CN when leaving the system, while the concentrate (reject) solution exited the RO system with an average CN content of 12.05 mg/L. The 2^{nd} stage permeate water undergoes secondary treatment by aeration in the Fresh Water Pond prior to being discharged. Cyanide levels observed at DD-ER averaged 0.010 mg/L with a maximum of 0.017 mg/L during the September sampling event. Samples collected at STA-3A never exceeded the detection limit for CN of 0.005 mg/L. **Figure C** presents the total cyanide concentration results from the different sample locations along with the MDEQ Aquatic Life Standards for cyanide.



Ammonia

Influent ammonia levels began the year higher than previous years and steadily increased throughout the 2013 treatment year. Ammonia levels in the effluent (i.e., water exiting the RO system) showed a decreasing trend during the first half of the treatment season and then began to increase in September. The same pattern can be seen in ammonia levels at the direct discharge station DD-ER, ranging from 0.57 mg/L to 1.18 mg/L, during the treatment season. This increase, however, was not seen farther downstream at the monitoring station along German Gulch, STA-3A. The ammonia levels at STA-3A were below the method detection limit of 0.05 mg/L for all biweekly samples during 2013. These values are far less than the calculated chronic aquatic life standard of 3.58 mg/L. The aquatic life standards for ammonia are determined by a formula provided by DEQ 7 (i.e., State water quality standards)(MDEQ 2012), wherein temperature and pH of the receiving stream are used to calculate a site specific ammonia standard. This formula also varies depending upon whether salmonids are present in the receiving stream. For the purpose of comparison, it is assumed salmonids are present in German Gulch immediately downstream of STA-3A. A graphical summary of the ammonia laboratory results from the past few years for the different sampling locations is presented below as **Figure D**.



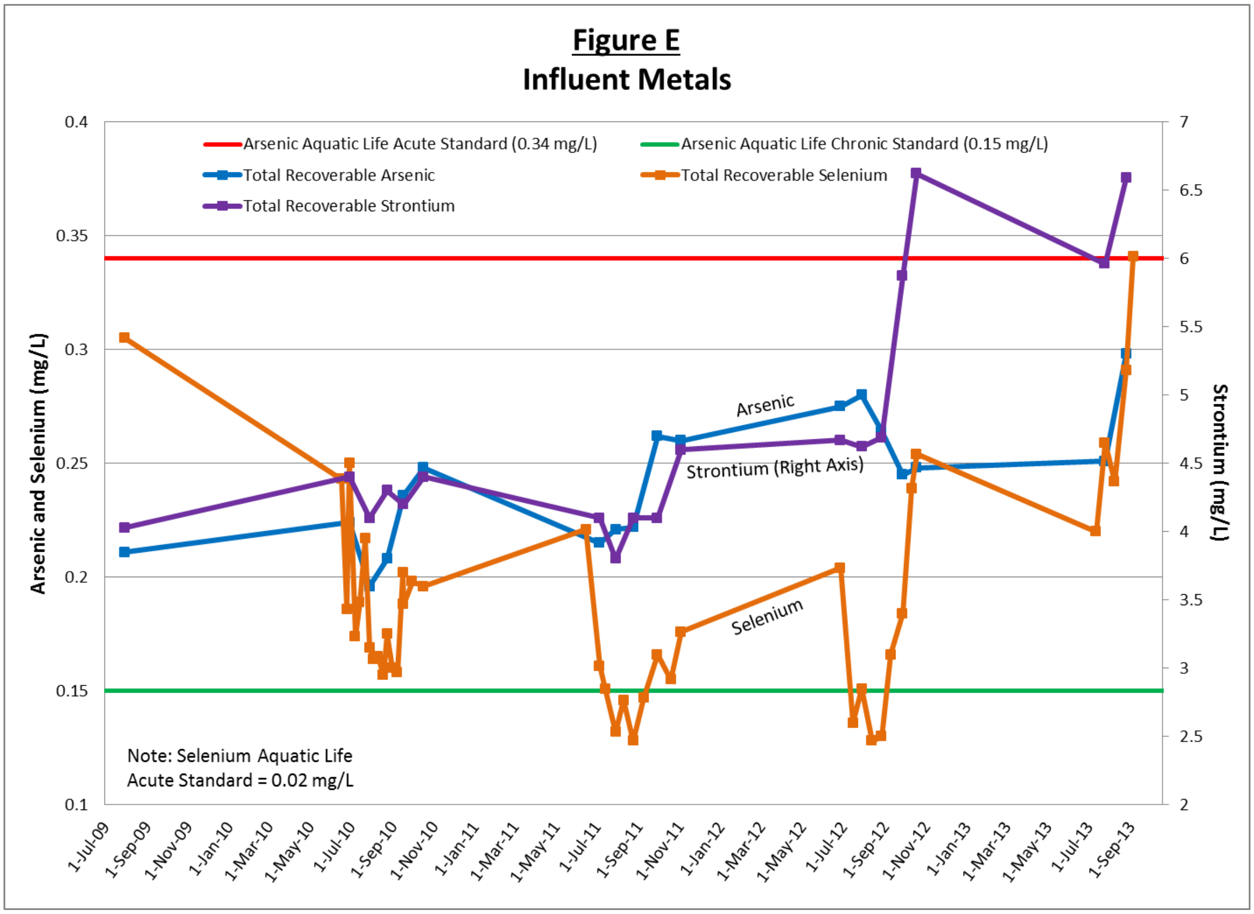
Metals

The 2013 treatment season saw metals, such as arsenic, selenium and strontium at increasing levels in the RO influent (**Figure E**). There was a slight decrease in strontium and selenium levels during the winter months between the 2012 and 2013 treatment seasons. Influent arsenic levels saw a slight increase from the end of the 2012 season to the start of the 2013 season. Influent selenium concentrations saw the most significant increase, from 0.220 mg/L to 0.341 mg/L, during the 2013 treatment season. Strontium levels in the influent water also saw a considerable increase from 5.96 mg/L to 6.59 mg/L. The reject water (**Figure G**) showed significant increases in the same three metals; arsenic, selenium, and strontium. The rising trends of metals in the influent and reject water may be related to the discharge of the reject water back into the heap leach pad and/or the reduction of "fresh" water seeping into the leach pad each year due to cap repairs.

Samples collected from the two direct discharge station have never been analyzed for metals under the Beal Mountain Mine water treatment work orders. However, according to the site wide monitoring program STA-3A has been analyzed semi-annually for metals that include arsenic and selenium. The 2013 Water Resources Monitoring Summary explains arsenic concentrations at STA-3A were about equal to the Human Health Standard but were below the chronic aquatic life standard for 2013. The summary also states that selenium concentrations exceeded chronic aquatic life standards during both monitoring events but are consistent with historic data. The 2013 Water Resources Monitoring Summary discusses that it is unclear where these concentrations are originating from but shows that similar levels of arsenic and selenium were seen at STA-3A prior to the operation of the water treatment plant. (Tetra Tech, 2013)

Near the end of the 2013 treatment season selenium concentrations in the effluent water (**Figure F**) were observed at a maximum level of 0.011 mg/L. This value is twice the MDEQ

Chronic Aquatic Life Standard of 0.005 mg/L but still below the Acute Aquatic Life Standard of 0.020 mg/L (MDEQ, 2012). This exceedance occurred around the time when the leach pad was reaching its lowest water level. It is believed that the increased selenium concentration was caused by the increased metal concentrations in the raw water due to lack of dilution. Historical patterns have shown that the water added to the leach pad during the winter months dilute the selenium levels to concentrations below any MDEQ standard. A considerable drop in effluent strontium concentrations was observed between November 2011 and July 2012. The reason for this drop was due to a change in the laboratory reporting limit for strontium from 0.1 mg/L to 0.01 mg/L.



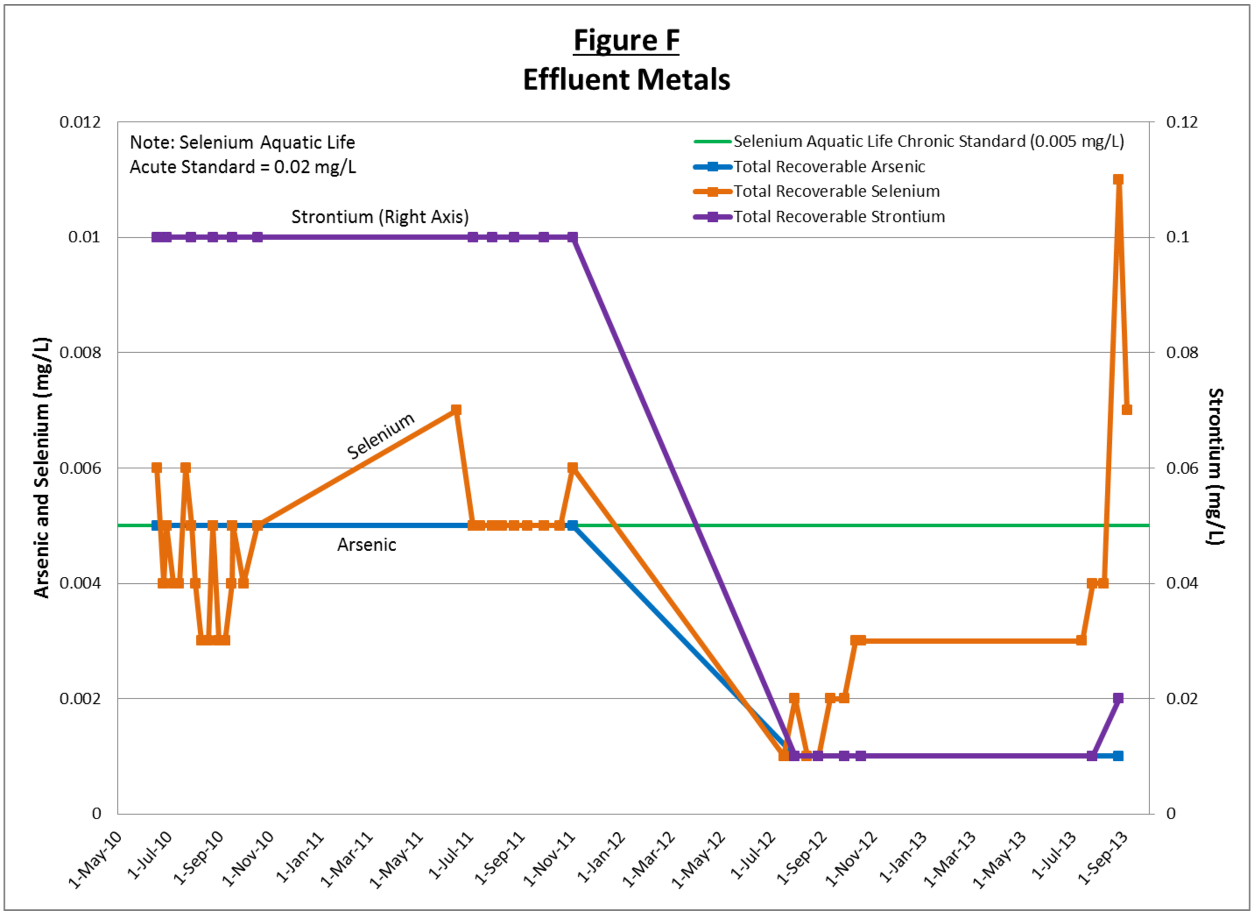


Figure F
Effluent Metals
Note: Selenium Aquatic Life
Acute Standard = 0.02 mg/L
Selenium Aquatic Life Chronic Standard (0.005 mg/L)
Total Recoverable Arsenic
Total Recoverable Selenium
Total Recoverable Strontium
Strontium (Right Axis)
Selenium
Arsenic
Arsenic and Selenium (mg/L)
Strontium (mg/L)
0.012
0.01
0.008
0.006
0.004
0.002
0
0.12
0.1
0.08
0.06
0.04
0.02
1-May-10
1-Jul-10
1-Sep-10
1-Nov-10
1-Jan-11
1-Mar-11
1-May-11
1-Jul-11
1-Sep-11
1-Nov-11
1-Jan-12
1-Mar-12
1-May-12
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1-Nov-12
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1-Jul-13
1-Sep-13

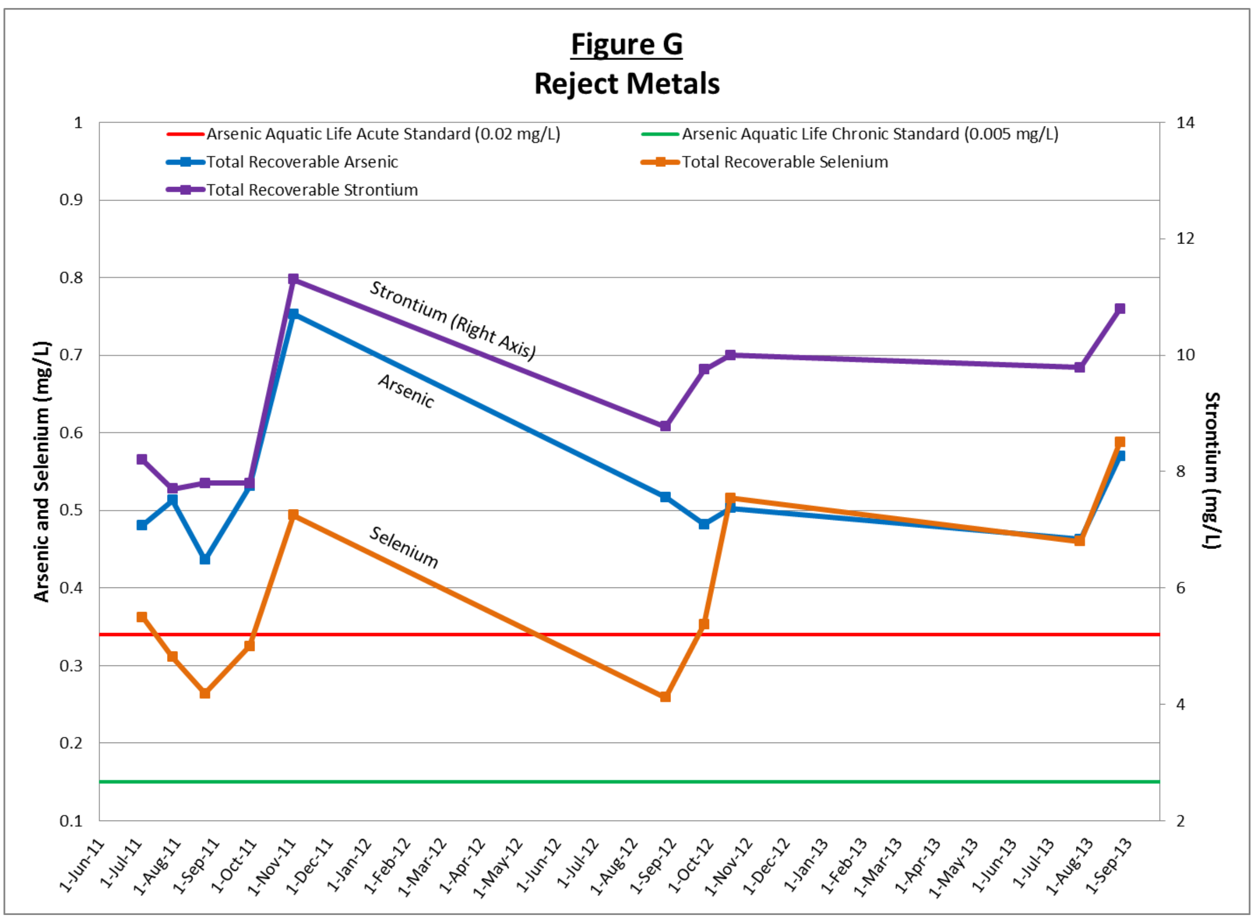


Figure G
Reject Metals
Arsenic Aquatic Life Acute Standard (0.02 mg/L)
Arsenic Aquatic Life Chronic Standard (0.005 mg/L)
Total Recoverable Arsenic
Total Recoverable Selenium
Total Recoverable Strontium
Strontium (Right Axis)
Arsenic
Selenium
Arsenic and Selenium (mg/L)
Strontium (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
14
12
10
8
6
4
2
1-Jun-11
1-Jul-11
1-Aug-11
1-Sep-11
1-Oct-11
1-Nov-11
1-Dec-11
1-Jan-12
1-Feb-12
1-Mar-12
1-Apr-12
1-May-12
1-Jun-12
1-Jul-12
1-Aug-12
1-Sep-12
1-Oct-12
1-Nov-12
1-Dec-12
1-Jan-13
1-Feb-13
1-Mar-13
1-Apr-13
1-May-13
1-Jun-13
1-Jul-13
1-Aug-13
1-Sep-13

Leach Pad Geochemical Modeling

After the completion of the 2012 treatment season geochemical modeling was performed for the leach pad water (Tetra Tech, 2013a). The idea behind the modeling was to use the previous volume and laboratory analysis data to predict which contaminants of concern would limit the amount of water that could be removed from the leach pad before RO effluent concentrations would exceed DEQ discharge standards. The other purpose of the modeling was to evaluate whether additional pre-treatment procedures would need to be implemented due to increasing concentrations of key contaminants.

For the 2013 treatment season, the modeling projected that the Beal Mountain treatment facility would be able to extract up to 20 million gallons of treated leach pad water resulting in approximately 6.5 million gallons of water remaining in the leach pad without running into major issues with scaling or with contaminants other than ammonia exceeding the discharge standards. The effluent selenium concentration was projected to be close to the limit of 0.005 mg/L by this point. The model assumed that there would be 16 million gallons of recharge, the total volume of the leach pad would be approximately 26.5 million gallons, and RO recoveries would remain at approximately 60%. Under these assumptions, selenium was found to be the contaminant that would likely go over the discharge limit if 16 million gallons or less recharge occurred and more than 20 million gallons of treated water was discharged in 2013. Modeling results also predicted that selenium would exceed discharge standards when the volume of the leach pad dropped below 7.5 million gallons.

The model assumed there would be approximately 16 million gallons of recharge into the leach pad for 2012/2013. According to actual depth to water measurements and using the rating table developed in 2006, the leach pad was calculated to take on just over 14 million gallons. Although the actual was two million gallons less than the projected value, the difference should not drastically affect the modeling projections. It should be noted that the volume taken on by the leach pad is calculated and inconsistencies have been observed with the rating table used in these calculations (Tetra Tech, 2013a).

Ammonia, cyanide, and selenium were the only contaminants by Tetra Tech's modeling to become a concern due to elevated levels. Actual end of season influent cyanide results were similar to model projections. End of season effluent cyanide results were less than half the model prediction, which was also true for the start of season influent cyanide values. The actual influent ammonia concentration at the start of the season was greater than the predicted value, yet the end of season influent and effluent results were approximately half of the model projections. Influent selenium concentration results near the end of the season were very similar to predicted. The actual results from the 2013 treatment year confirmed the key point projected by the geochemical modeling. According to the model projections the concentration of effluent selenium would be close to the limit of 0.005 mg/L when there was approximately 6.5 million gallons of water remaining in the leach pad. The sample results from August 26, 2013 show the selenium level above the limit of 0.005 mg/L with the volume of the leach pad believed to be close to the 6.5 million gallon value. Unfortunately, at that time the water level in the sump had been pumped below the reach of the transducer so there is no depth to water reading, however, a manual depth to water reading was taken on September 25, ten days after the system was shut down, was used to calculate a volume of 6.3 million gallons. This shows that as the residual water volume approached the 6.5 million gallon mark the selenium levels began to exceed the limit, as projected by the model. Unfortunately, due to apparent inconsistencies between the rating table and measured volume of water removed from the leach pad, it was unknown exactly how much water was left in the leach pad near the end of the 2013 treatment season.

Dewatering Activities

Four dewatering wells (DW-2, DW-3, DW-4, and DW-5) in the vicinity of the Clay Sill and West Wall slide areas (**Figure 2, Appendix A**) were activated on June 29, 2013. As specified in Task 5, Sub-Task No. 3 of the Beal Mountain Mine Year 6 Proposal, the discharge was recorded by the RO plant operator on a daily basis or whenever he was onsite. For days when a site visit was not conducted, total flow has been interpolated based on readings before and after the missing days. The system was shut down and winterized on September 25, 2013. Total gallons pumped for the period of June 29th through September 25th is 273,226.10 gallons, and is distributed as follows:

- DW-2 = 80,624.6 gallons
- DW-3 = 24,143.9 gallons
- DW-4 = 17,836.8 gallons
- DW-5 = 150,620.8 gallons

ISSUES/CONCERNS/REMEDIES FROM THE 2013 TREATMENT YEAR

Treatment Rate

The 2013 season never saw the RO production rate reach the gallons per minute treatment numbers from the previous seasons. The average treatment rate during the 2012 season was much higher than 2013, probably due to the increasing concentrations of contaminants in the influent. A summary of the starting and ending treatment rates from the last four seasons is presented in Table 3.

Table 3 - RO Treatment Rates

Treatment Season	Starting Treatment Rate (gpm)	Ending Treatment Rate (gpm)
2010	185	183
2011	164	130
2012	171	161
2013	132*	114

Note: * Starting treatment rate once system was running at full capacity.

During shut down in November 2012, no membranes were disposed of, however three membranes were designated “heavy” based upon visual inspection and excess weight due to scaling. Based on cleaning and testing results, the three membranes were discarded. Since only three membranes were deemed “heavy”, they were the only filters shipped for testing.

Prior to startup in 2013, the Forest Service purchased three new first pass membranes to replace the three discarded due to testing results. The weights of the remaining membranes removed from the system were compared to the weights of the membranes discarded from previous seasons and it was decided that testing was not necessary prior to the 2013 season. Since 87 of the total 107 total membranes in the system had been replaced before the 2012 season, most of the membranes had only been in the system for a single season.

A mid-season cleaning was conducted to maximize the life of the membranes. The 2013 treatment rate began the season at 121 gpm but once the plant reached full capacity it was treating around 132 gpm. The treatment rate decreased to 126 gpm just prior to the mid-season cleaning, which was performed on August 13th and 14th. After cleaning the system pressures saw a drop and the treatment rate increased to 146 gpm. The 2013 season ended with the system treating 114 gpm. The 2013 treatment season was considerably shorter than in 2012, but the RO system still managed to treat almost 14 million gallons of water.

The last four years have seen decreases in the treatment rate during the season due to gradual scaling of the membranes. As the concentrations of salt and contaminants increase in the leach pad due to lack of water a decrease in the treatment rate has been observed. The ending treatment rate in 2011 increased over 20% to start the 2012 season due to the replacement of a majority of the membranes. At the start of the 2013 season the treatment rate decreased 18% from the end of the previous season, we believe is due to the membranes not storing well and the possibility of biological foulants growing during storage.

<u>System Availability</u>
The 2013 season saw only two unscheduled shut downs, one due to the replacement of a leaking check valve in late July and again in mid-August due to a pipe failure at the well head. The mid-season cleaning in mid-August along with a soak in mid-September were the only two scheduled shutdowns experienced by the system during the 2013 season. This is similar to the 2012 system availability. The system availability from the last few years is as follows:

- 2009 - online 76% of the time
- 2010 - online 96% of the time
- 2011 - online 97% of the time
- 2012 - online 97% of the time
- 2013 - online 94% of the time

<u>Scaling and Membranes</u>
During the 2013 end of season shutdown of the system, there was slightly more evidence of calcium sulfate deposits on the membranes compared to 2012. At the beginning of the 2012 treatment season 87 of the membranes were new and only three were replaced following that season. During the 2013 shutdown, some membranes were noticeably heavier than the previous year. After a visual and physical inspection these membranes were deemed ruined. A total of 18 membranes were disposed of during the 2013 shutdown and all the remaining membranes were allowed to drain before being packaged and transported to a heated garage bay where they will be stored for the winter. It is recommended that a select few of the stored membranes be sent in for testing to determine the approximate condition of the remaining membranes. Once the effectiveness of the stored membranes has been determined the membranes that need to be replaced can be added to the 18 filters previously disposed of and a total number of new membranes can be ordered from Water and Power Technologies.

<u>Water Quality</u>
Cyanide concentrations in the influent (raw water) and reject (concentrate returned to leach pad) water increased in 2013 relative to 2012. Effluent (treated water) concentrations were above MDEQ Water Quality Standards (MDEQ, 2012). Although the effluent water left the system with elevated cyanide levels, the treated water was aerated in the treated pond and the samples collected from direct discharge location DD-ER (direct discharge-end of rock) remained below the Acute Aquatic Life Standard. The cyanide concentrations for the sampling locations along the treatment flow path have increased from previous years, except STA-3A, which remained under the detection limit for cyanide for the duration of the season.

Throughout the 2013 treatment season an increase in ammonia levels was seen at all sampling locations except STA-3A, which remained under the detection limit for the duration of the season. The influent, effluent, and DD-ER all reported increases during 2013. Ammonia concentrations in the influent water began the year at 18.7 milligrams per liter (mg/L) and ended the year at 22.0 mg/L, the effluent began the season at 1.5 mg/L and ended at 3.3 mg/L and, the DD-ER began the year at 0.72 mg/L and ended at 1.18 mg/L. All of the samples collected after the treatment plant were below the Chronic Aquatic Life Standard for ammonia in surface water of 3.58 mg/L. In order to lower ammonia levels earlier in the discharge process the clean water pond was kept at a higher level to allow more aeration of the water prior to discharge. The discharged water is also aerated as it flows down the direct discharge ditch toward German Gulch.

The concentration of metals in the influent continued to increase as well. Arsenic levels in the influent water began the season at 0.251 mg/L and ended at 0.298 mg/L. Strontium concentrations began the year at 5.96 mg/L and finished the year at 6.59 mg/L. The most significant increase was seen in selenium levels which started the year at 0.22 mg/L and finished at 0.341 mg/L. This is an anticipated trend, due to the return of the reject water back into the heap leach pad. The rate at which these and other metals increase in concentration, along with the load of dissolved salts (TDS) may require the design and implementation of additional pre-treatment processes for future treatment seasons.

Heap Leach Pad Water Volume

The annual water accumulation rates on the heap leach have seen a decline since the completion of the Heap Leach Cap Repair project in August 2011. Projections show that the leach pad solution volume will likely increase approximately 16 million gallons during the winter of 2013-2014. The geochemical modeling projected that the leach pad can be treated down to a level of approximately 7 million gallons remaining on the pad before the selenium effluent concentration would be close to exceeding 0.005 mg/L chronic aquatic life standard. Elevated TDS concentrations at solution volumes less than 7 million gallons are likely to lower selenium removal efficiencies. The leach pad solution volume increased just over 14 million gallons over the 2012-2013 off season. The 2013 treatment season ended with a leach pad volume of approximately 6.3 million gallons, however, the selenium concentrations exceeded the chronic aquatic life standard in the effluent samples around this time.

The RO treatment plant will need to continue operating to account for the water taken on when the system is not being run. The system will, however, either need to be run for much shorter periods of time or with extended periods of time between operating seasons. Since the heap leach volume needs to stay above 7 million gallons due to the above mentioned RO treatability restraints, it would be most feasible to allow the leach pad volume to increase to a volume greater than the previous contract amount so a full season of treatment can be conducted. If recent patterns continue, the leach pad solution volume will increase approximately 16 million gallons. The addition of this anticipated water to what was remaining on the pad at the end of 2013, according to the existing rating table, would result in a value that would limit the treatment volume for next year's treatment season and the contracted treatment of 24.5 million gallons per season would be unattainable. If the system was run every other year it may be possible to treat close to 24.5 million gallons assuming the system takes on approximately 14 million gallons each year. Another option would be to come back every five or six years to treat the water that has accumulated in the heap leach. This would allow for a full treatment season, due to an increased heap leach volume, and possibly increased treatment rates with the dilution of salt and other contaminant concentrations.

The geochemical modeling performed after the 2012 treatment season has proved to be very useful for better understanding the concentrations of contaminant levels with the decreasing leach pad volume. One of the major reasons geochemical modeling was performed was to evaluate whether pretreatment would be needed for the RO plant to continue treating water. The results of the modeling showed that as long as the leach pad volume was kept above 7 million gallons and the recharge is below 25 million gallons annually, the selenium concentration and gypsum saturation would be at a level that could be handled by the RO plant and no additional pretreatment would be needed. This result was confirmed during the 2013 season when the leach pad volume dropped to a minimum of 3.6 million gallons and the selenium concentrations in the effluent were seen at levels exceeding the chronic aquatic life standard for selenium, proving that the RO was not able to adequately remove selenium. If the leach pad volume is to be dropped below approximately 7 million gallons a pretreatment option will likely need to be added to lower selenium levels prior to entering the RO system.

One final issue of concern identified during 2012, and continuing into 2013, is the accuracy of the rating table used to calculate the volume of solution remaining on the leach pad. During 2012, treatment system flow meters indicate approximately 25 million gallons were removed from the leach pad. A review of **Figure B** (which is based on the rating table) suggests that the solution volume in the leach pad dropped approximately 45 million gallons during the 2012 treatment season. Then in 2013, the treatment flow meters showed that just less than 14 million gallons of water were treated by the RO system. Referring back to **Figure B**, it is shown that the leach pad volume decreased by approximately 23 million gallons during the 2013 treatment season. During 2002 and 2005 the leach pad was dewatered. During these events, depth to solution was periodically measured from top of steel casing in Sump 1 and a corresponding solution elevation calculated. At the same time the volume removed was recorded. These changes in volume and corresponding elevations are believed to be the foundation for the available rating table. In order to accommodate solution levels (and therefore volumes) greater than observed (7,481 feet or 30 million gallons), a model was developed by Tetra Tech in 2006 using Eagle Point software, available leach pad design drawings, and an assumed porosity to calculate the available pore volume for one foot elevation increments. Unfortunately this table has proven to be inaccurate at the lower leach pad elevations. Three possible reasons for the table inaccuracies are as follows:

- First, both the 2002 and 2005 dewatering events occurred prior to any leach pad cap repairs and occurred in the spring when influx of ambient water was the highest. Therefore, a greater volume of solution needed to be pumped out in order to obtain the same elevation change which results in over estimating the volume change per foot.
- Secondly, there are no As-Built drawings of the leach pad to accurately define the final leach pad configuration.
- Finally, there is no site specific data defining leach pad material porosity, and the porosity has been reduced from 2002 to present by precipitation of salts from the reject water injected into the leach pad.

Dewatering Activities

Approximately 10,000 fewer gallons of water was pumped from the dewatering system during 2013 compared to 2012. The reduced volume was partially due to a 26 fewer days of operation but primarily due to well DW-4 being out of service most of the season with a faulty controller that continued to malfunction. Surface electrical control components for this well were identified as non-repairable, hence, a new controller unit was ordered and installed by a licensed electrician.

References:

MDEQ 2012. Circular DEQ-7 Montana Numeric Water Quality Standards, Montana Department of Environmental Quality, Helena, MT, October 2012.

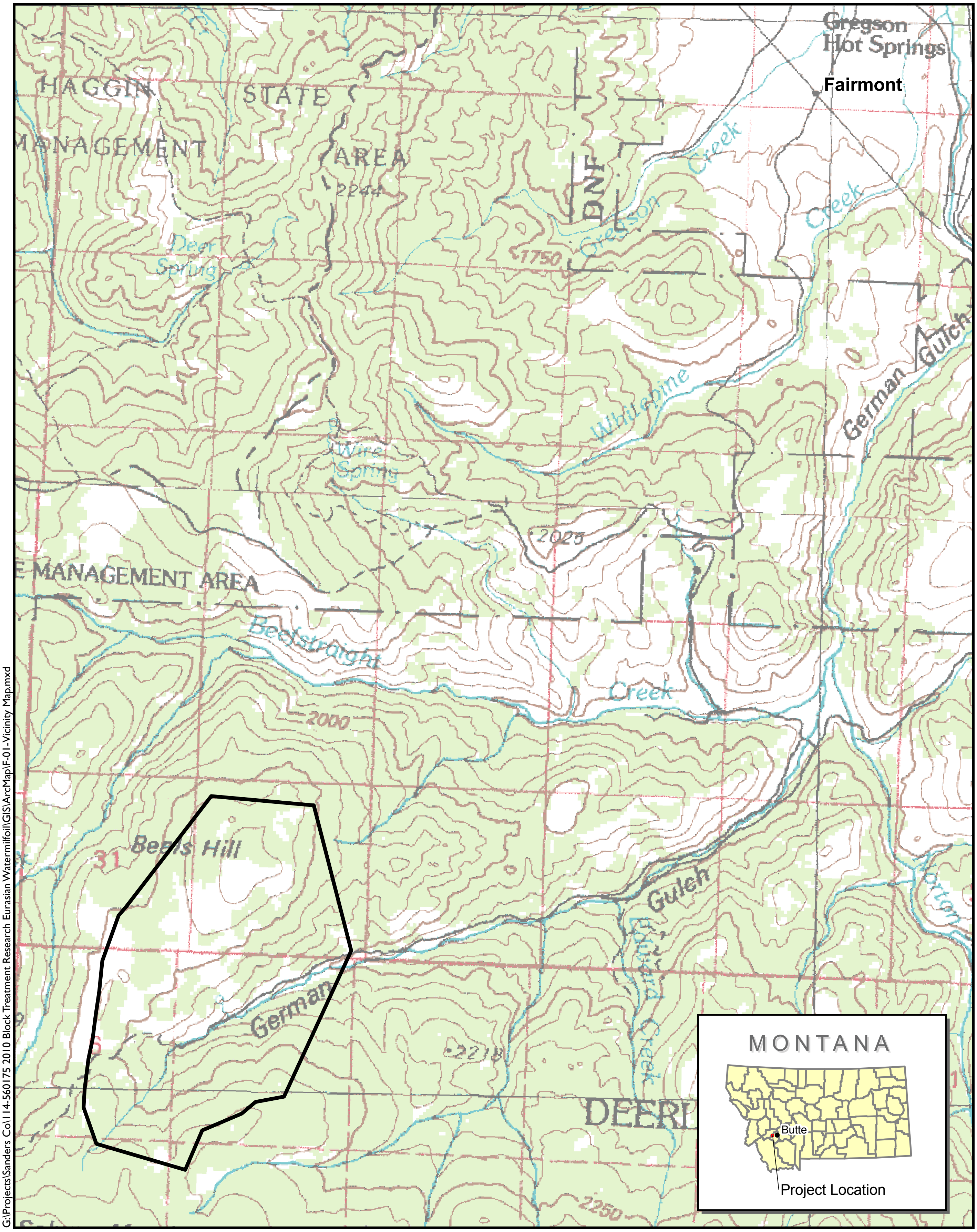
Tetra Tech 2012. 2012 Reverse Osmosis Water Treatment Plant Sampling and Analysis Plan, Tetra Tech, Helena, MT, December 3, 2012.

Tetra Tech 2013a. Final – Beal Mountain Mine Heap Leach Pad and Treatment Chemical Modeling. Tetra Tech, Helena, MT, March 13, 2013.

Tetra Tech 2013b. Reverse Osmosis (RO) Year Six Water Treatment and Monitoring Proposal, Tetra Tech, Helena, MT, April 4, 2013.

Tetra Tech 2013c. 2013 Water Resources Monitoring Summary, Tetra Tech, Helena, MT, December 2013.

APPENDIX A
FIGURES

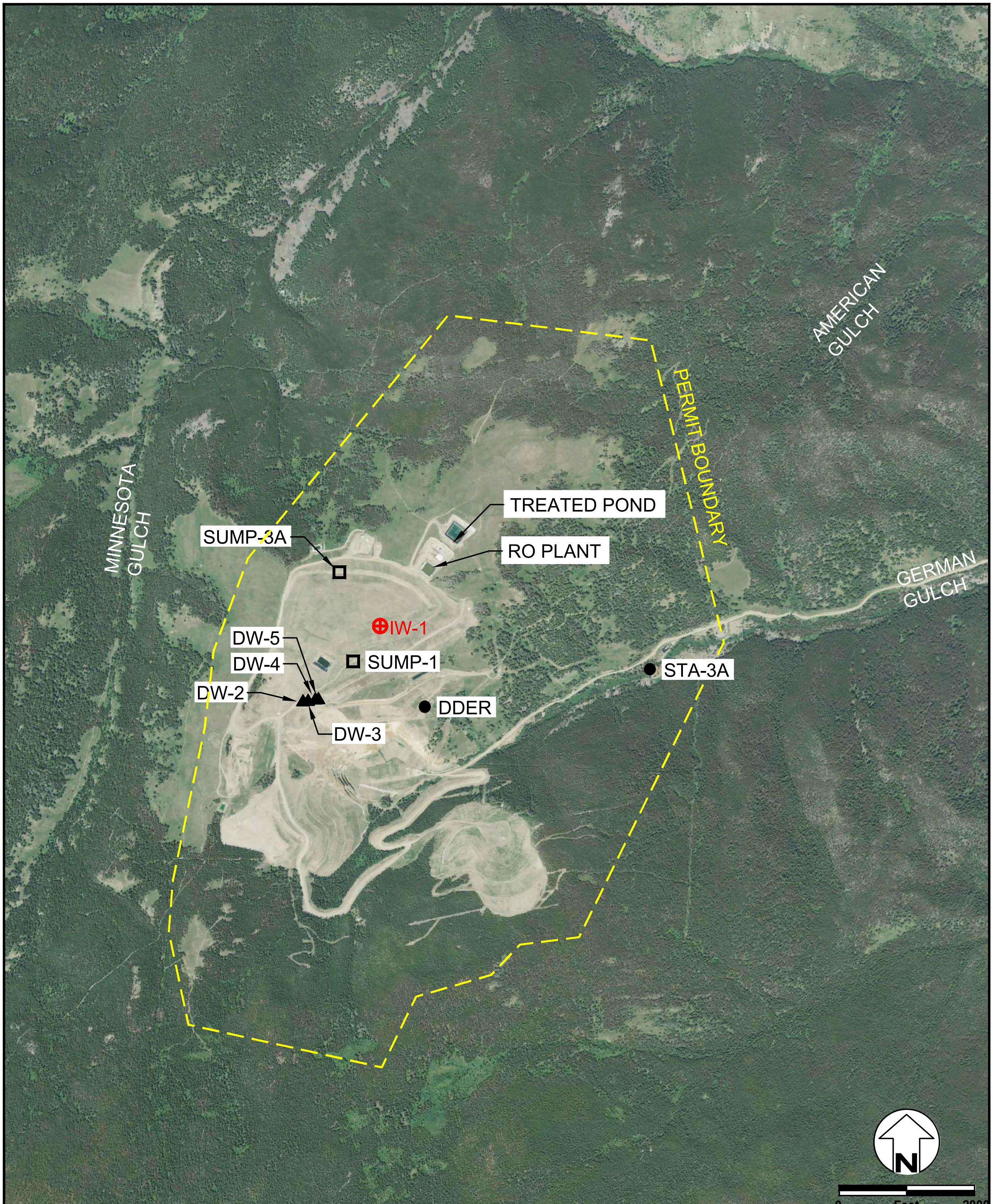


USGS 24K SERIES TOPOGRAPHIC MAP

N
W E
S

0 0.25 0.5 1 Miles

Vicinity Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 1



▲ 2013 Dewatering Well

□ 2013 Sump

● 2013 Direct Discharge

⊕ 2013 Injection Well

2013 Water Monitoring Locations
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 2

APPENDIX B
DAILY ACTIVITY LOGS

Daily Operations Field Log 2013

	Target	29-Jun	1-Jul	3-Jul
Check Chemical Feeds		1:15	11:40	15:40
Anti-Scalant (Vitec 7000)	**10 mL/min**			
Estimated Gallons in Drum =		55	40	35
Total unused Drums On-site (stock 2 - 55 gal drums) =		0	0	0
Polymer (RoQuest 3000) Mix 5 gal/gal water	**6 mL/min**			
Estimated Gallons in Drum =		12	5.25	12
Total unused 5 gallon Totes (stock 4, 5gal totes) =		15	15	14
Potassium Permanganate/Regeneration of Greensand				
Regeneration Y or N		N	N	N
Total Unused 5 Gallon Pails =				
Sodium Bisulfite (Based on chlorine test - Start 25lb/50gal/48hr))		100	43	120
est (if >0.1mg/l at 1st stage feed then increse concentration)				
Total Unused 50 Pound Bags (Stock 5 50lb bags) =				16.5
Record Pressures (psi)				
Well Pump	55 psi	60	60	60
Inlet Pressure (PT A001)		60	60	60
Media Filter 1 (A100)				
Inlet (PI A101)		57	58	57
Outlet (PI A102)		57	57	57
Media Filter 2 (A200)				
Inlet (PI A201)		57	57	58
Outlet (PI A202)		57	58	57
Media Filter 1 (A300)				
Inlet (PI A301)		57	57	57
Outlet (PI A302)		58	57	58
Media Filter Differential				
Differential (PDI A002)		6.5	6.5	12
Prefilters (cartridge)				
Inlet (PI T002)		56	55	56
Outlet (PI T102)		52	51	53
Differential (PDI T002)	<12 psi	4	4	3
Cartridges Changed?		Y	N	N
Maintain three sets of 24 filters onsite at all times				
1st Stage RO Feed				
Before Pump (PI E100)		52	51	53
After Pump (PI E101)	250-300	344	336	344
Interstage (PI E103)	245	326	318	327
1st Stage Permeate (PI E102)	43	54	53	55
1st Stage Concentrate (PI E104)	220	176	170	185
2nd Stage RO Feed				
Before Pump (PI E300)		51	50	51
After Pump (PI E301)	200 psi	273	263	270
Interstage (PI E303A)	174 psi	234	223	229
Interstage (PI E303B)	156 psi	218	207	212
2nd Stage Permeate (PI E302)		12	12	12
2nd Stage Concentrate (PI E304)	139 psi	182	174	177
Percent Recovery				
1st Stage RO	68max - shutdown if over max	60	62	65
2nd Stage RO	94 max	70	72	72
System Total	64			
Flow (gpm)				
Plant Feed at Well				
Instantaneous (gpm)		289	292	286
Total (gallons)		162,657,536	163,773,728	164,728,336
Influent at Filter (FIT A001)				
Instantaneous (gpm)	335	301	307	297
Total (gallons)			1,600,369	2,485,829
1st Stage RO Feed (FI E100)				
Instantaneous (gpm)		271	281	272
1st Stage Permeate (FIT E102)	222-235	159	171	173
1st Stage Concentrate (FIT E104)	95-105	106	104	93
2nd Stage Permeate (FIT E302)	190-200	121	128	132
2nd Stage Concentrate (FIT E304)	>22	51	50	52

9-Jul	12-Jul	18-Jul	22-Jul	25-Jul	29-Jul	8-Aug	12-Aug
11:25	12:00	15:00	13:00	11:00	11:15	11:45	12:45
45	35	15	35	20	5	20	4
2	2	2	1	1	1	2	2
6	6.5	5	12	5.5	4.25	12	3.5
12.5	12	11	9.75	9.75	9	7	6.5
N	N	N	N	N	N	N	N
45	23	35	120	40	20	120	15
15.5	15	14	11.5	11.5	10	8.5	8.5
60	60	60	60	60	60	60	60
60	60	60	60	60	60	60	60
58	57	56	56	55	55	55	55
57	57	55	56	55	55	55	55
58	58	56	56	56	56	55	56
57	56	54	55	54	54	55	54
58	58	56	56	56	56	55	56
57	57	55	56	55	55	56	55
13	14	8	16	16	16	21	21
55	55	54	54	53	53	54	53
51	51	50	50	49	49	50	49
4	4	4	4	4	4	4	4
N	N	N	N	N	N	N	N
52	52	50	51	50	49	50	49
344	345	352	345	345	345	348	350
328	328	325	327	327	327	330	332
54	53	54	52	51	51	52	51
183	182	240	181	180	179	178	177
50	50	50	49	48	47	49	47
268	268	330	268	268	268	270	270
228	228	267	228	228	228	230	231
212	212	226	212	212	212	213	215
12	12	12	12	12	12	12	12
177	177	175	177	177	177	179	180
64	64	64	64	63	63	62	62
72	71	72	72	72	72	71	71
286	285		287	285	283	281	281
167,401,472	168,792,496		173,381,424	174,718,096	176,442,304	181,003,472	182,864,432
293	295	295	294	295	295	293	293
4,957,131	6,242,610	8,816,452	477,795	1,704,835	3,288,591	7,450,955	9,147,634
267	265	265	265	260	260	256	250
168	167	166	166	162	161	157	151
93	93	94	94	95	95	94	94
131	131	131	131	130	129	129	126
52	52	50	51	51	51	52	52

15-Aug	23-Aug	26-Aug	30-Aug	3-Sep	5-Sep	9-Sep	12-Sep
			11:45	15:30	11:30	12:30	14:00
50	30	60	37	23	10	35	40
1	1	0	0	0	2	1.25	1
10	20	10.5	3.25	10.5	7	4	12
6	10	4	4	2.5	7.5	7	6
N	N	N	N	N	N	N	N
95		115	13	120	68	15	120
7.5		4.5	4.5	10.5	10.5	10.5	10
60	60	60	60	60	60	60	60
60	60	60	60	60	60	60	60
55	56	56	55	56	55	55	55
55	55	56	55	56	55	55	56
55	56	56	56	56	56	56	55
55	54.5	55	54	55	55	54	55
55	56	56	55	56	55	55	55
55	55	56	55	56	56	55	56
21	22	21	21	21	21	21	21
53	53	54	53	54	54	53	55
49	48	50	48	50	49	48	50
4	<5	4	<5	4	<5	<5	<5
N	N	N	N	N	N	N	N
48	48	50	48	50	49	49	50
341	340	351	353	356	359	361	368
323	320	332	333	336	339	341	351
50	50	51	50	51	51	50	52
178	177	177		179	182	183	196
47	46	48	47	48	48	47	49
265	260	272	273	275	273	276	272
221	230	232	235	236	236	240	236
205	200	218	220	220	224	229	221
13	13	13	13	13	12	12	12
177	185	187	190	189	194	198	185
61	60	59	57	56	56	54	52
80	78	76	75	74	75	75	70
305	280	291	288	286	278	274	264
183,248,448	187,269,280	188,601,488	190,352,784	192,258,720	193,098,688	194,959,376	195,872,176
313	293	309	301	300	289	289	274
9,503,498		4,732,235	6,376,622	8,164,281	8,943,196	626,364	1,436,800
269	273	247	239	234	228	220	211
160	164	142	132	125	122	111	108
103	105	100	101	99	96	96	99
146	142	136	132	130	128	127	114
37	40	44	44	47	43	43	48